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LAMINATE CERAMIC CAPACITORS

CLAIM(S)

A laminate ceramic capacitor having an internal electrode and an external electrode conducting to said internal electrode, characterized in that said external electrode is made of thermosetting resin containing a metal powder.

DETAILED DESCRIPTION OF THE INVENTION

(Field of Industrial Application)

The present invention pertains to a laminate ceramic capacitor, particularly to an inexpensive and highly reliable laminate ceramic capacitor.

(Prior Art)

A laminate ceramic capacitor is primarily consists of ceramic dielectric body, internal electrode installed inside it, and of external electrode conducted to said internal electrode. In the prior art laminate ceramic capacitor, the external electrode is manufactured by mixing an admixture of

precious metal powder and glass frit in an organic vehicle, coating this on the ceramic dielectric body, and by sintering this at nearly 600 - 800°C.

(Problems of the Prior Art to Be Addressed)

The prior art laminate ceramic capacitor, wherein the external electrode is thus manufactured, comes with the following problems.

- 1) The manufacturing cost is high due to a need of high temperature sintering.
- 2) The quality of manufactured laminate ceramic capacitor is controlled by the influence of humidity resistance of glass frit and by the sintering parameters, so it is difficult to manufacture a highly reliable laminate ceramic capacitor.
- 3) Cracks may possibly generated in the dielectric body by temperature cycles since the external electrode has a highly rigid metal sinter structure.

The present invention, to solve the aforementioned problems, attempts to present a highly reliable laminate ceramic capacitor that has an excellent characteristic and can be manufactured at low cost.

(Means to Solve the Problems)

The laminate ceramic capacitor of the present invention has an internal electrode and an external electrode conducting to the internal electrode, and the external electrode is characterized by its being constructed by a thermosetting resin containing a metal powder.

The present invention is explained in detail below.

The metal powder constituting the external electrode of the laminate ceramic capacitor of the present invention is not limited to a specific type, but any proper metal powder used for the external electrode of the prior art laminate ceramic capacitor can be used. More specifically, other than precious metal powders such as a silver (Ag) powder and a palladium (Pd) powder, a metal powder such as nickel (Ni) powder or the mixed powder of them can be used.

The thermosetting resin is preferably cured at a temperature ranging from 180°C to 250°C. As specific examples of thermosetting resin, phenol resin, xylene resin, and urethane resin can be cited.

The thermosetting resin is mixed with the metal powder, put into a paste form, and coated on the dielectric body in which is formed the internal electrode; and by subsequently heat-curing it, the external electrode can be easily formed. If the paste viscosity is too high when the paste is prepared, a proper solvent, for example, butyl carbinol, is mixed. In this case, the mixing ratio of the metal powder, thermosetting resin, and solvent is not limited to a specific ratio, but it is generally selected from the following range: 50- 80 weight % of metal powder; 5 – 20 weight % of thermosetting resin; 5 – 30 weight 5% of solvent.

When the external electrode of the laminate ceramic capacitor is formed, the metal powder, the thermosetting resin, and solvent, if needed, by a specific amount for each are mixed into a paste. Then, the paste is coated on the external electrode and cured. The rest of the process is the same as the process of manufacturing the prior art laminate ceramic capacitor. The thermal curing temperature is generally a curing temperature of the used thermosetting resin, for example, generally 180 - 250°C for about 30 minutes.

(Operation)

The laminate ceramic capacitor of the present invention does not require high temperature-sintering since its external electrode is formed by curing the metal powder mixed with thermosetting resin. Therefore, a highly reliable laminate ceramic capacitor with a stable quality can be manufactured at low cost. With this laminate ceramic capacitor having such an external electrode, cracks are not generated in the dielectric body by thermal warping of the external electrode.

(Embodiment)

The present invention is explained more specifically with reference to the embodiment example and its comparative example.

Embodiment Example 1 and Comparative Example 1

The Ag paste with the following mixture was coated on the lead perovskite group ceramic dielectric body and cured at 200°C for 30 minutes, and thus the laminate ceramic capacitor of the present invention was manufactured.

Ag paste mixture (weight%)

Ag powder (average particle size 2 μm): 75

Thermosetting resin: 6.2

Solvent: the remaining portion

The electrical characteristic of the manufactured laminate ceramic capacitor was examined by the following method, and compared to the laminate ceramic capacitor (comparative example 1) made of sintered type external electrode of the prior art.

The result is shown in Table 1. The test was conducted on 30 units of sample (20 units for a humidity-resistant load test), and the maximum, minimal, and average values of the capacity and $\tan \sigma$ were indicated. Also, the maximum and minimal values of the insulation resistance were indicated.

Capacity (nF) and $\tan \sigma$ (%)

They were measured by 1 KHz and 1 V.

Insulation resistance (Ω)

After charging 25 V and DC for 5 minutes, the value after 30 seconds is indicated.

Durability at temperature cycle

The heat cycle of -25°C (30 minutes) \rightarrow normal temperature (3 minutes) $\rightarrow +85^{\circ}\text{C}$ (30 minutes) was repeated by 100 cycles, and the number of units in which the capacity was reduced was indicated.

Reliability test (humidity-resistance load test)

DC 16 V was charged at $+85^{\circ}\text{C}$ and 85% RH for 1,000 hours. The presence or absence of deterioration was examined.

Table 1

Examples	Capacity (nF)			Tan σ (%)			Insulation resistance (Ω)		Temperature cycle-resistance (unit)	reliability
	Max	Mini	average	Max	Mini	Average	Max	Mini		
Embodiment 1	1116.6	1014.4	1060.3	2.47	2.07	2.28	4.2×10^9	3.2×10^9	0	No deterioration after 1000 hours
Comparison 1	1085.7	1015.2	1053.4	2.62	2.07	2.28	4.9×10^9	3.2×10^9	2	No deterioration after 830 hours

As is evident from the table, the laminate ceramic capacitor of the present invention was excellent in characteristics and in stable quality and was proved to be a highly reliable laminate ceramic capacitor.

(Advantage)

As explained above, the present invention can present a highly reliable laminate ceramic capacitor excellent in various characteristics and in stable quality that can be manufactured at low cost.

Translations

U. S. Patent and Trademark Office

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